

PATENT
S.N. 10/604,878

AMENDMENT TO THE CLAIMS

- 1-9 canceled
10. (currently amended) A system for estimating velocity ahead of a drill bit disposed in a subsurface formation, comprising:
at least one seismic source on a surface for generating seismic waves in the vicinity of a borehole traversing the formation;
at least one seismic receiver in the borehole for detecting seismic waves reflected from a reflector ahead of the drill bit;
~~a telemetry system for transmitting data between the seismic receiver and the surface;~~ and
at least one processor adapted to process instructions for determining velocities ahead of the drill bit using travel times of seismic waves reflected from the reflector and seismic wave data obtained with a seismic receiver on the surface to detect seismic waves generated with a source on the surface.
11. (original) The method of claim 10, where the drill bit is substantially at the same depth for the different source positions.
12. (original) The system of claim 10, wherein the processor further comprises instructions for converting velocities to pore pressures ahead of the drill bit.
13. (currently amended) The system of claim 10, further comprising a tool that determines arrival times of seismic waves detected by the seismic receiver in the borehole.
14. (original) The system of claim 13, wherein the processor is further adapted to process instructions for determining the travel times from the arrival times.
15. (original) The system of claim 13, wherein the tool is located near the drill bit.
16. (currently amended) The system of claim 10, wherein the seismic receiver in the borehole is disposed on a drill string.
17. (original) The system of claim 10, further comprising at least one clock for synchronizing, generating, and detecting the seismic waves.

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18. (original) A method of estimating velocity ahead of a drill bit disposed in a subsurface region, comprising:
obtaining surface seismic data for a region of interest;
during drilling of a borehole traversing the subsurface region, determining a travel time of a seismic wave generated from a surface of the region to a location in the borehole when the drill bit is at selected depths in the borehole;
determining a velocity from the travel time and the selected depths; and
inverting the surface seismic data to determine a velocity ahead of the drill bit while constraining velocity between the surface and the drill bit to be consistent with the velocity determined from the travel time.
19. (original) The method of claim 18, further comprising transforming the velocity ahead of the drill bit into pore pressure of a region ahead of the drill bit.
20. (original) The method of claim 18, wherein the seismic wave is generated by a seismic source positioned near an opening of the borehole.
21. (original) The method of claim 18, wherein determining the travel time of the seismic wave comprises detecting the seismic wave from at least one seismic receiver at a location in the borehole.
22. (original) The method of claim 21, wherein the seismic receiver is disposed in a downhole tool near the drill bit.
23. (original) The method of claim 21, wherein determining the travel time further comprises measuring the arrival time of the seismic wave detected at the seismic receiver and determining the travel time from the arrival time.
24. (original) The method of claim 23, wherein measuring the arrival time comprises sending the seismic wave detected in the borehole to the surface and processing the detected seismic wave at the surface to determine arrival time.

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25. (original) The method of claim 23, wherein measuring the arrival time comprises processing the seismic wave detected in the borehole to determine the arrival time and sending the arrival time to the surface via telemetry.
26. (new) A method of estimating velocity ahead of a drill bit disposed in a subsurface region, comprising:
generating seismic waves from a surface of the region when the drill bit is disposed in a borehole traversing the subsurface region;
obtaining seismic wave data associated with the surface generated waves at one or more locations in the borehole; and
inverting the obtained seismic wave data with surface seismic data obtained for the region to determine a velocity ahead of the drill bit.
27. (new) The method of claim 26, further comprising transforming the determined velocity into pore pressure of the subsurface region.
28. (new) The method of claim 27, wherein the surface seismic data is obtained for the subsurface region before the borehole is formed in the region.
29. (new) The method of claim 27, wherein the surface seismic data is obtained for the subsurface region after the borehole is formed in the region.
30. (new) The method of claim 27, wherein the surface seismic data is obtained for the subsurface region during drilling of the borehole in the region.